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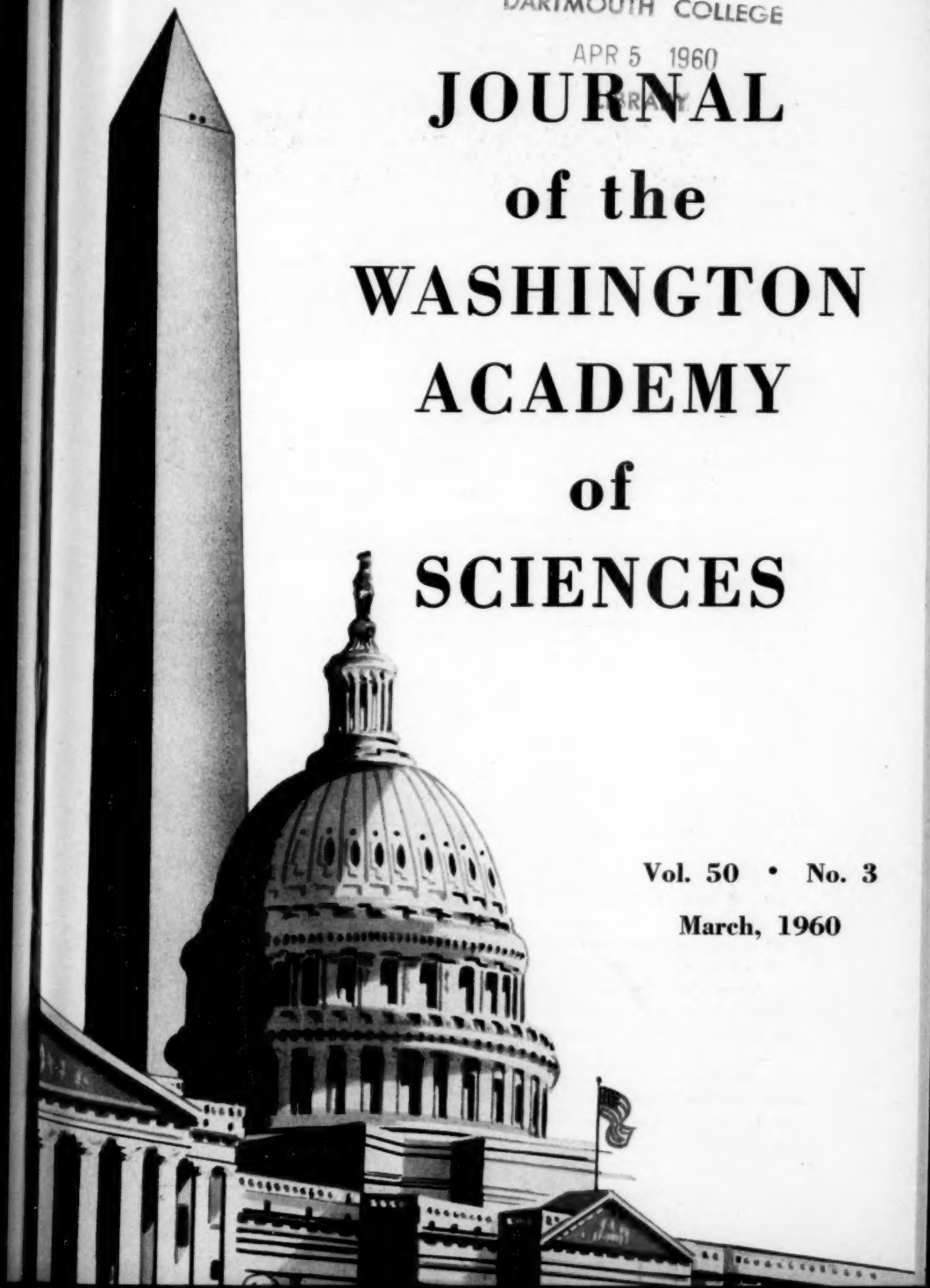

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Chemistry, Food, and Civilization

Synthetic Organic Chemistry Ushers in A New Era of Civilization

Archibald T. McPherson

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The Washington Academy of Sciences and its affiliated societies embrace a wide range of interests in the physical, biological, and earth sciences, and engineering. The members of the Academy, as individuals, living at this critical time in history, are deeply concerned with broad social, political, and economic problems as well as with their own scientific endeavors. Consequently it is appropriate for a retiring president to address the Academy on an important problem of world affairs, and for him to relate his own field of science to this problem. Accordingly, the problem to be considered in this address will be that of providing sufficient and adequate food for the world's explosively expanding population; the solution that will be proposed will stem from the field of synthetic organic chemistry.

The Population Problem

A major problem confronting statesmen and scientists today is that of stepping up food production at a rate which will keep pace with the explosive increase in the world's population. The unprecedented increase in population has come about largely through advances in sanitation and the elimination of infectious diseases which have greatly increased the span of human life.

The ultimate solution of the population problem lies in the field of social science; but social changes that will limit the population will, of necessity, be slow, and it is unlikely that they can be implemented in time to meet the present emergency. To gain the necessary time the physical scientist must provide an immediate solution.

The problem of food supply is not new. At the dawn of civilization 9,000 years ago food was scarce and food gathering was the principal concern of man. Even so, the population of the better-favored regions of the earth probably did not exceed one or two persons per square mile. The world population was probably about one million persons, and was certainly less than five million.

The development of agriculture at about 7,000 B.C. permitted an enormous increase in population, after which a condition of saturation was slowly reached. From the heyday of the Roman Empire up to about 700 A.D. the world population was relatively stable and has been estimated at about 200 to 300 million people. The population dropped during the Dark Ages, particularly with the devastation of the plagues; but it rose again during the Renaissance; and at the beginning of the present scientific age it has been estimated at about 545 million. Since 1650 the world population has been increasing at an ever accelerating rate. Figures recently released by the United Nations Department of Economic and Social Affairs give 2,497 million as the world population in 1950 and 3,828 million as the estimated population in 1975. Considering North America alone, the population increased from 137 million to 190 million in the short interval from 1933 to 1950.

In the light of these increases both abroad and on our own continent the present abundance of food and the large crop surpluses in the United States and Canada appear to be a very minor and transitory factor in the world food picture. These sur-

This address, of a retiring President of the Washington Academy of Sciences, was delivered February 19, 1959.

pluses are large in relation to the population of the United States, but our population is only 7 percent of the population of the world. If, by some miracle of transportation, our surpluses could be distributed among the underprivileged peoples of China who subsist on 1800 calories per day, and among the only slightly more favored peoples of India, Burma, the Philippines, and Japan who live on 2000 to 2300 calories per day, such surpluses would suffice for only a few weeks to bring the diets of the ever-hungry peoples to the 3070 calorie average of the American population.

Vigorous efforts are being made to increase the food supply of the perpetually hungry countries by improved agriculture, by bringing more land under cultivation, and by improving the practices of food storage, preservation, utilization, and distribution. In agriculture two developments —one, present, and the other, in prospect —are of particular significance for increasing the food supply. They are the production of chemical fertilizer, and the soilless culture of both present crops and new types of crops.

Greatly increased crop yields are possible through the use of fertilizers specifically designed for local soil conditions. These fertilizers can be produced in very large quantities by the fixation of nitrogen from the atmosphere and by obtaining potassium, calcium, phosphorus, and other essential elements from mineral deposits.

The soilless culture of plants gives promise of being a much more efficient operation than conventional agriculture from the standpoint of the utilization of space and materials. The techniques are applicable to many though not all common food plants and afford the possibility of developing special types of algae and other new food plants which may prove highly efficient as food crops. Some algae have been developed which give a high yield of protein; other algae produce fat, and still others, carbohydrates. Heretofore the cost of tanks has presented a major problem in soilless culture. Now, however, tanks can be provided very simply by the use of inexpensive plastic film supported by earth embankments as is done for small swimming pools.

It is difficult to estimate how rapidly and to what extent these and other means will increase the production of food by agriculture. However, with the present supply of food barely adequate, it seems improbable that agricultural production can be stepped up so rapidly as to supply a more adequate diet and, at the same time, keep up with the rapidly growing population. Certainly agricultural production cannot be increased indefinitely and the inexorable law of diminishing returns will slow down and ultimately check the increase in production.

A similar situation exists in relation to increasing the supply of food through better preservation, storage, and distribution. A practical limit will be reached in the utilization of food at which the waste and other losses will be so small that further improvements can have no effect on the over all food situation.

In earlier ages when the population exceeded the food supply equilibrium was restored by mass migration or by widespread starvation. Today, barriers on immigration and the lack of suitable undeveloped land will prevent any extensive population movement. Under previous governments the Asiatic peoples have submitted to mass starvation, but with the present political leadership any large food deficit might precipitate a conflict between the have- and the have-not nations with disaster to both.

To meet the growing emergency, then, it is necessary to look for a solution that is entirely new but yet practical and capable of speedy implementation. There can be such a solution,—indeed, a solution that has such vast potentialities that it cannot only meet the present emergency, but it can usher in a new era of civilization.

The Chemist's Solution

The solution is based on the fact that it is now possible to make all substances essential for human nutrition by synthesis.

The raw materials required may be the chemical elements themselves or any readily available materials containing these elements. The raw materials that are the most practical at the present time are petroleum or coal as sources of carbon, nitrogen from the atmosphere, and phosphorus, sulfur, calcium, chlorine, fluorine, manganese, and other elements from mines or from the ocean.

The methods of synthesis, for the most part, are still in the laboratory stage. Before large-scale manufacture can be achieved it will be necessary to develop practical chemical engineering processes, and to build manufacturing plants. To accomplish such a development in the space of a few years will require a major coordinated research program comparable in magnitude to the present atomic energy program. The engineering phase of this investigation will require facilities of much larger capacity than the present chemical engineering industry in its entirety. However, the experience in previous crash programs, such as the wartime production of synthetic rubber, indicates that there will be no insuperable difficulty if a far greater program is undertaken. In the synthetic rubber program the output of synthetic rubber in less than three years reached a level that was approximately as high as the plantation industry had been able to achieve in 30 years.

The Beginnings of Agriculture

The production of food by synthesis affords the possibility of as far reaching a change in human affairs as was brought about by the discovery or development of agriculture about 9000 years ago. Agriculture made possible our present civilization by providing a reasonably dependable source of food that could be produced on a small area and stored for use throughout the year. This availability of food permitted large groups of men to live together in fixed habitations and gave them time for activities other than food gathering and thereby enabled each new generation to build upon the discoveries and knowledge accumulated in the past.

The early development of agriculture is still shrouded in darkness, and archaeologists are only beginning to obtain definite information about it. Very probably this discovery took place in the vicinity of the Tigris-Euphrates valley. The well known Fertile Crescent bounds this valley on the northeast, the north, and the northwest. A hilly zone flanking this crescent appears to archaeologists to have been the habitat of potentially domesticable plants and animals.

One of the earliest sites authentically associated with agriculture is the village of Jarmo. Braidwood, who excavated this site, states [1] "Jarmo must lie near, but not at the very beginning of the era of village-farming communities; in my judgment this beginning should be put at about 7000 B.C. It should be made clear that Jarmo is *not* conceived as *the* spot where the village-farming community level of existence came into being—we do not believe that there ever was one single such spot—but only that Jarmo represents the earliest example of settled village life which the accident of prior discovery has allowed us to use as a basis for description."

Solecki [2] in excavations of the cave of Zawi Chemi Shanidar found querns and manos dated as 10,870 years old or about 2000 years earlier than Jarmo. These querns and manos were presumably used for the grinding of cereal foods, but no evidence was found as to the identity of the grain or other material. Thus the domestication of plants and the practice of agriculture may have been slow and random in the early stages, but, once developed, the advantages were so many and so obvious that the village-farming pattern of life quickly spread throughout the Tigris-Euphrates valley, and from there into other areas.

The economy of Jarmo was based on the

[1] Science *127;* 1419, June 20, 1958.

[2] Solecki, Ralph S. (Smithsonian Institution), Private communication.

Fig. 1. The Fertile Crescent bounds the Tigris-Euphrates Valley, on the east, north and west.

cultivation of wheat and barley and the keeping of herds of goats and sheep. From the standpoint of nutrition there was good reason for this combination of vegetable and animal foods, as will be discussed later in this paper.

The Jarmo "Academy of Sciences"

Some early discoveries in science, mathematics, and engineering were undoubtedly made in villages such as Jarmo. It is very probable that senior citizens of Jarmo came together to discuss these discoveries and to exchange speculations about strange phenomena of nature that they now had the time and opportunity to investigate. We can imagine that these gatherings were about an evening fire for warmth and sociability. An early mathematician in the group may have developed a system of counting jars of grain in his storehouse and dividing them by the number of moons so as to assure a uniform supply of food for his household until the next harvest. A primitive engineer may have found how to burn brick in order to construct rain-resistant buildings. An early metallurgist —this was long before the discovery of bronze—may have made some tools from bits of meteoric iron picked up in the desert that were vastly superior to the bone and flint tools then in common use.

Not all of the discoveries were of a utilitarian nature. Undoubtedly some keen observer who guarded the herds at night must have noted that the star which we know as Algol waned in brightness for a brief period at intervals of about 3 days.

Agriculture, Food, and Civilization

At times the discussions around the evening fire at Jarmo undoubtedly centered on their mode of life, and the great advantages that they enjoyed over the people who still lived in the desert or the wilder-

ness and subsisted by hunting and the gathering of food where they found it. The leader of such a discussion may have pointed out that the city of Jarmo—it is estimated to have had about 700 inhabitants—occupied no more land with its fields and pastures than had previously been the hunting ground of a single family in the time of their ancestors. Such a speaker would undoubtedly have noted the great advantages of a fixed abode with houses to provide shelter and an abundant year-around food supply. He would have looked forward to a time when all of the inhabitants of the earth would live in cities such as Jarmo, and that it would no longer be necessary to fight for the possession of hunting grounds and caves because the new method of living would provide food and shelter for vastly more people and would give them leisure to cultivate the arts and learn about the strange and wonderful world in which they lived.

The title of such a discourse might have been, "*Agriculture*, Food, and Civilization." Our title this evening is "Chemistry, Food, and Civilization."

Chemistry of Life Processes

The bold assumption that chemistry can make as great a contribution to civilization in the next century as agriculture did 9000 years ago is based on the fact that the chemist has produced from non-living materials almost if not all of the substances essential to human nutrition. Furthermore many of the less abundant and more expensive of these substances are already being manufactured in relatively large tonnages. This does not mean that plant and animal tissues have been duplicated, but rather that the basic substances which they provide for the nutrition of the body have been synthesized, and that these substances are identical in every respect with the substances obtained from plant or animal sources. This identity has been established by a large amount of research, beginning with the classic chemical investigations of Wöhler in 1828, and continuing through a great number of chemical researches and feeding studies up to the present time. Whenever the feeding of synthetic materials has failed to satisfy nutritional requirements for normal growth it has invariably been found that some previously unrecognized essential constituent was present in trace amounts in the natural product but not in the synthetic. Such a finding has been at once a challenge to the chemist to separate, identify, and ultimately to synthesize the missing constituent.

The plant or animal grows and produces substances such as carbohydrates, fats, proteins, and vitamins by chemical reactions. Many of these reactions are well known and have been duplicated in the laboratory. The chemist, in synthesizing natural products, is by no means restricted to the reactions by which they are made in nature. He is often able to use simpler and more efficient methods of production.

Synthesis of Non-Food Agricultural Products

The major contribution that the chemist has thus far made to the problem of feeding the world has not been through the synthesis of food materials themselves, but rather through the synthesis of non-food agricultural products and the consequent freeing of agricultural lands for food crops. Many common products that were once obtained from plant or animal sources are now manufactured in large quantities by direct synthesis from petroleum, coal, atmospheric nitrogen, and other non-living materials. The extent to which synthetic products have displaced natural products is shown in Table 1. Dyes lead the list

Table 1. Natural Products now Made Synthetically*

Dyes	99 percent
Drugs and medicines	75 percent
Resins and plastics	97 percent
Paints	60 percent
Soap and detergents	59 percent
Rubber	52 percent
Textiles	25 percent

* The Chemical Industry Facts Book, 2nd Ed., p. 5, Manufacturing Chemists' Assoc., Washington, D.C., 1955.

with 99.5 percent synthetic production, and only textiles, with the enormous crops of cotton and wool, are still derived from natural sources to the extent of more than 50 percent.

Alizarin. It was only about 100 years ago that Perkin synthesized the dye, alizarin, which gives the color commonly known as turkey red. Chemically alizarin is 1,2-dihydroxyanthraquinone; it is readily made from coal tar as a raw material. Until 1870, 12 years after its synthesis, the sole commercial source of alizarin was the madder root, which was cultivated in France and other parts of Europe to the extent of 400,000 acres. The yield of pure dye from this area was about 750 tons per year, or only about 4 pounds per acre. By 1914 the cultivation of madder had been completely abandoned and the world supply of alizarin—now 2000 tons of the pure dye per year—was the output of a few men working in chemical manufacturing plants.

Indigo. The replacement of natural indigo by the synthetic product was accomplished at about the same time. In 1897 India produced 8,000 tons of the familiar blue dye; but only 17 years later, in 1914, the once thriving and lucrative plantations produced only 4 percent of the world's supply of the dye, in spite of extremely cheap labor.

Dyes, drugs, and other products that were among the first to be made synthetically had the advantage of being relatively small in tonnage and high in price, and hence could give a large return on the investment in facilities for their production.

Rubber. Rubber was the first product in the large volume—low price category to be synthesized commercially on a large scale. Prior to World War II relatively small quantities of Neoprene had been produced and sold at about a dollar a pound in competition with natural rubber at less than 10 cents a pound because of its superior oil-resistant properties. The shutting off of natural rubber during the war led to a crash program which, in the brief space of 3 years, produced large tonnages of both general purpose and special purpose synthetic rubbers at a cost in the same range or even below the price of natural rubber.

Under the stress of competition the per-acre yields of natural rubber have been greatly increased and economies in production have been effected that were not thought possible before the war. The different synthetic rubbers compete with natural rubber for the manufacture of some products because of superiority of their properties for particular applications. In other areas the competition is on a price basis. One synthetic rubber is identical in composition with natural rubber but, on account of cost, it is not yet in commercial production.

To illustrate the impact of the synthesis of rubber on the world food situation, let us assume that the land used for the growing of rubber would produce foodstuffs equivalent in calories to the rubber. Let us assume further that food requirements amount to 2350 calories per person per day, a high figure for Asiatic countries where most of the rubber is grown. On this basis the 1,054,625 long tons of synthetic rubber produced in the United States in 1958 would have required, if grown on plantations, land capable of providing food for 12 million people.

A broader view of the possible effect of synthesizing non-food agricultural products may be had by comparing the food and the non-food items in the world farm output. The summary in Table 2 shows that 88 percent of the farm output, weighted by prices, is in food items, and 12 percent in non-food items. Thus the complete replacement of cotton, wool, tobacco, rubber, coffee, tea, and other natural products by synthetic materials would release enough land to feed many million people, but the maximum that could be accomplished in this way would provide for the increase in population that would occur in 5 or 6 years.

Food Compared with Other Sources of Energy

The production of food by synthesis

Table 2. World Farm Output (Quantities weighted by prices)*

Food:	Wheat	10 percent
	Rice	10 percent
	Meat	20 percent
	Milk	15 percent
	Other	33 percent
	Total food products	88 percent
Non-food:	Cotton	4 percent
	Wool	2 percent
	Tobacco	2 percent
	Rubber	1 percent
	Coffee and tea	1 percent
	Other	2 percent
	Total non-food	12 percent

* Anon., "New Statistical Light on the World's Farm Output," Foreign Agriculture (United States Department of Agriculture), p. 14, April, 1958.

would employ petroleum, coal, and wood as the principal raw materials, together with atmospheric nitrogen and inorganic mineral products. Petroleum, in the form of either oil or natural gas, is now the principal raw material for the synthesis of rubber, resins, plastics, and other large-volume synthetics. Petroleum and coal, and to a lesser extent wood, are likewise the world's principal sources of energy for heat and power. Hence, it is important to look at the quantities involved to determine whether the wholesale production of food by synthesis would seriously deplete the raw materials needed for other sources of energy.

As has already been mentioned the energy content of the food consumed in the United States is 3070 calories per person per day, and is the highest of any country in the world. At the other extreme is mainland China with only 1830 calories per person per day. For purposes of the present calculation 2500 calories per person per day may be taken as the world-wide average. Then the energy requirement for the 1950 world population of 2,497 million was about 6.0×10^{12} calories per day or 2.2×10^{15} calories per year. In terms commonly used for fuels this figure is 2.55×10^{12} kilowatt hours.

The energy required for food is shown in comparison with the other sources of energy in Table 3. The heating value of the wood produced is practically the same as the food energy while the heating value of the oil is twice as great and that of the coal, four times as great. Thus, neglecting the energy that would be required in manufacturing operations, all of the food for the world could be synthesized from about one-seventh of the fuel supply.

In the United States the situation is quite different. While each person consumes 3070 calories per day in food, the fuel that he uses directly or indirectly in coal, oil, gasoline, and natural gas amounts to 160,000 calories per day. Hence, only one-fiftieth of the consumption of energy from other sources would suffice to provide the calories needed in food.

Looking to the future the fossil fuel resources of the world would quickly be exhausted if all countries should come to use fuel to the same extent as the United States. However, solar energy and nuclear energy will undoubtedly be called upon to replace fossil fuels to an increasing extent as sources of heat and power. The role that solar energy can play is indicated by the figures in the table which show that the solar energy reaching the land amounts to 100,000 times the energy represented by all of the food consumed in the world. The potentialities of atomic energy are vast, but no reliable estimates of the future en-

Table 3. World Sources of Energy *

	Energy per year (Unit, 10^{12} KW hr)
Food consumed by human beings	2.55
Wood production	2.5
Oil production	6.0
Coal production	10.5
Water power production	0.4
Photosynthesis by land vegetation	45.
Solar energy reaching the land	260,000.

* Table compiled from data by Thirring, Hans, "Energy for Man," p. 164, p. 222, and p. 262, Indiana University Press, Bloomington, 1958.

ergy production from this source can as yet be made. With the advent of the utilization of solar energy and atomic power, it may be possible to conserve the reserves of fossil fuel for chemical synthesis, including the synthesis of food.

Present and Potential Manufacture of Different Types of Food

Having made the general determination that food manufacture is possible and feasible, consideration will next be given to the specific accomplishments that have been made to date, and to the methods which appear practical for future development. In making this survey consideration will be given to the three major constituents of foods—carbohydrates, fats, and proteins—and to the minor constituents—vitamins, minerals, colors, and flavors. These minor constituents are minor only in the sense of being small in percentage.

Carbohydrates. Carbohydrates are the principal source of energy in the human diet and are the cheapest and most abundant food products in nature. The yields in which starches and sugars can be produced by agriculture render it unlikely that they will be an early target for commercial synthesis. Carbohydrates can, however, be synthesized directly from carbon by the following schematic reactions,

$$n\,C + \tfrac{1}{2}nO_2 \rightarrow n\,CO$$
$$CO + H_2 \rightarrow HCHO$$
$$6\,HCHO \rightarrow C_6H_{12}O_6$$

If the chemist is called upon to meet shortages of carbohydrates it is unlikely that he would use these reactions. Instead, he would probably turn to cellulose as the raw material since it is produced in nature in great abundance as the principal constituent of all plants, both terrestrial and marine.

Cellulose can be readily broken down by acid catalysis to forms of lower molecular weight, and ultimately to glucose. Under accurately controlled conditions the yield of glucose from cellulose is quantitative. Cellulose serves as a food for cattle and other ruminants because it is broken down by microorganisms in the rumen to a form capable of being assimilated, presumably glucose. It is likewise through the instrumentality of microorganisms that the termite is able to subsist on a diet of wood.

The production of edible carbohydrates from the cellulose in wood or woody materials is entirely possible, but the cost of removing lignin and other interfering materials and obtaining cellulose in a reasonably pure form is such that production is not economically profitable in competition with the growing of sugars and starches at the present time.

If the production were economically feasible it would provide a means of utilizing the vast amounts of waste paper produced in the United States. The annual consumption of paper and paper products in the United States is 34.5 million tons, or 400 pounds per person, in round num-

bers. Assuming that half of this paper is discarded and that it could be collected in the form of clean waste paper, it would amount to 200 pounds per person per year. This could be converted to about 180 pounds of edible carbohydrate, or about one-half pound per person per day. This amount of carbohydrate would provide about 900 calories, or a little less than one-third of the daily energy requirement.

Much larger amounts of cellulosic material are available from other sources such as farm crop wastes, and wastes in the production of lumber which may amount to more than one-half of the wood in the tree.

Fats. Fats are glycerides of both unsaturated and saturated fatty acids. Those most common in nature are the glycerides of palmitic, stearic, and oleic acids. The natural fats are mixtures of the glycerides of various fatty acids. Those in which the saturated fatty acids predominate are solid at room temperature; those in which the unsaturated fatty acids are in the larger proportion are liquid. The liquid fats such as cottonseed oil or whale oil can be readily converted to solid fats by hydrogenation, as is done in the production of oleomargarine.

In the process of digestion fats are broken down to the corresponding fatty acids and glycerine. Hence, for purposes of nutrition it would be necessary to supply only the requisite fatty acids. However, present day preferences relating to taste, consistency, and other factors would doubtless call for the glycerides rather than the fatty acids themselves.

Fats were produced in Germany during World War II from the paraffin-like products obtained by the hydrogenation of carbon monoxide. These paraffins were oxidized to the corresponding fatty acids which, in turn, were esterified with glycerine to produce low-melting fats. Reports state that these fats were of good taste and odor and that they were found to be digested and metabolized in the same way as the natural fats. For any really large scale synthesis of fats it would seem most practical to employ petroleum as a raw material and to separate or to build up from cracking products those hydrocarbons which could be oxidized to the desired fatty acids.

Unlike carbohydrates which appear to be interchangeable for meeting the body's energy requirements, certain fats are regarded as essential to the human diet. These are the fats of the unsaturated acids —linoleic, linolenic, and arachidonic acids. When more is learned about the role of fats in nutrition it may, at some future time, be desirable to undertake the synthesis of certain fats that might serve as dietary supplements. The current availability of fats from natural sources, however, is such as to discourage efforts at commercial production.

Proteins. Proteins are more critical items in the human diet than are carbohydrates or fats. They cost more, especially when derived from animal sources. They cannot be stored in the body, hence must be provided as needed. Furthermore, many proteins are not adequate to supply the body's needs, but must be supplemented by other proteins; for example, most plant proteins require the addition of some animal proteins to provide an adequate diet.

Proteins are high molecular weight polymers of amino acids and are usually made up of a number of different amino acids. Amino acids are characterized by an amino group, $-NH_2$, and a carboxyl group, -COOH. In the protein molecule the amino group of one amino acid is linked with the carboxyl group of another amino acid and this process is repeated so as to produce a chain. When the chain is short the product is a polypeptide; when the chain is long and the molecular weight is of the order of ten thousand to one million the product is a protein. The different amino acids in a given protein molecule are thought to be arranged in an orderly manner since the molecules, as viewed by the electron microscope, are uniform in shape and size, and may be crystalline.

The different amino acids differ widely in composition and structure, except for

the -NH_2 and the -COOH groups which all of them possess. Some are straight chain compounds; others contain benzene rings and other ring structures. Some are characterized by the presence of sulfur, and others by hydroxyl groups. Through the number and diversity of the amino acids the great number of different proteins found in nature are built up.

Proteins are utilized by the body in the form of amino acids into which they are broken down in the process of digestion. The amino acids themselves can be used to replace proteins in the diet, and are so used to some extent as will be discussed in subsequent paragraphs. For the human diet amino acids may be categorized as essential and non-essential. Eight are considered to be essential: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, and valine. The non-essential amino acids can be produced in the animal body from other amino acids or even from some other sources of nitrogen. Some authorities recognize three amino acids as semi-essential — histidine, tyrosine, and arginine. These can be formed slowly by the body from other substances, but under stress of growth the rate is too slow for the maintenance of normal conditions.

The proteins from actively metabolizing tissues, whether plant or animal, are complete. Thus meat, seed germ, growing grass, and growing microorganisms all provide essentially the same nutritive value from the standpoint of furnishing a complete protein. The percentages of protein that they contain are, of course, different, and they differ widely with regard to other constituents.

The storage proteins such as those in grain, on the other hand, are incomplete to a greater or lesser degree and must be supplemented to provide an adequate diet. Thus it was no accident that the early western civilization in villages such as Jarmo was based on a wheat-barley-sheep-goat economy. Meat and milk were essential to provide the amino acids that were lacking in the grains. All subsequent civilizations which have made extensive use of grains have supplemented the grains by animal food.

The Chinese economy, on the other hand, has been based from the early beginning largely on the cultivation of the soy bean, with relatively less attention to animal husbandry than in the west. The reason is that the soy bean provides a much more nearly complete protein than does grain, and a relatively small supplement of animal food is required. Efforts to introduce the soy bean into the American diet have met with little success because the large consumption of meat provides the essential amino acids in proportions better suited to human nutrition than would the soy bean.

The storage proteins from grain are deficient in only a few of the essential amino acids—principally lycine and methionine, or a combination of cystine and methionine. These deficiencies are made in the present-day diets by amino acids from meat, milk, eggs, or other foods of animal origin. The disadvantage of this practice is that the total protein consumption may include more of some proteins than actually needed in order to secure a sufficient quantity of those containing the scarce amino acids.

A logical procedure, then, would be to supplement the incomplete protein by the addition of just the requisite quantities of the amino acids needed to make it complete. This procedure is coming to be the practice in animal feeding, using synthetic amino acids. For example, methionine, which has the formula

$$CH_3SCH_2CH_2\underset{\displaystyle NH_2}{\underset{|}{C}}HCOOH,$$

is produced under the trade name, HYDAN, for use as a supplement in feed for poultry, swine, and other animals. It is used along with fish meal to supplement the proteins in grain. A vitamin supplement is also used. The effectiveness of these supplements is shown by the fact that it is now possible to produce 3-lb broilers with 25 percent less feed and in 2 weeks less time than formerly.

The use of amino acids in human food has lagged behind its use for the feeding of animals. However, one amino acid is currently sold in many food stores. It is glutamic acid, in the form of monosodium glutamate. Though almost tasteless itself, it is employed as a condiment since it has the property of augmenting the flavor of other foods; in soup or rice it gives the flavor of chicken. Because the amounts used are small and because the glutamic acid is not an essential amino acid, the monosodium glutamate cannot be said to serve any significant nutritional need.

The production of amino acids in 1957 was 4,345,000 lb. at market prices for the most part in the range from $1.25 to $2.25 per pound of the pure materials. At first glance these prices seem high in comparison with natural foods, but such is not the case when consideration is given to the net protein content. Meat, for example, contains only 10 to 20 percent of protein. Hence, to supply amino acids at $1.25 to $2.25 per pound meat would have to sell at 12½ to 45 cents per pound.

The relation between price, volume of production, and types of use of amino acids is illustrated by a market study that was made of lysine.[3] Lysine was first produced commercially in 1955 by extraction from natural sources at $12.00 per pound. In 1959 it was produced by a fermentation process at the rate of about 100,000 pounds per years at a price of $6.00 per pound. The major outlet was in the pharmaceutical industry for protein supplementation, appetite improvers, and vitamin formulations. It was also used in the food industry in specialty products such as high-protein breads and cereals. The market studies indicated that if the price could be reduced to $1.50 or $2.00 per pound the demand would increase by 50-fold. Even at $3.00 per pound lysine would be expected to move into the field of animal feeding as a supplement to the incomplete proteins of cotton-seed meal. An extrapolation of the curve showing the decrease in the price of lysine as a function of time indicates that the $2.00 per pound price may be reached by 1962 to 1964.

From the standpoint of chemical manufacture the production of amino acids is still in the stage of a small scale specialty operation. Large scale production would undoubtedly lead to a great reduction in the prices that now obtain. The only raw materials needed are petroleum, nitrogen of the atmosphere, and sulfur. All are available and cheap. In the early part of the century the fixation of nitrogen presented a major problem but now synthetic ammonia is produced in very large tonnages from atmospheric nitrogen. Ammonia is, of course, the substance used to introduce the amino group, $-NH_2$, into the amino acid molecule. Efficient, large-scale production of the amino acids might require the discovery and development of new reactions, and would certainly require extensive engineering research to put the processes into operation with automatic control. Experience in other fields of chemical manufacture indicates that all of this can be done within a relatively short time if sufficient manpower and funds are provided.

Vitamins. The composition and structure of vitamins have presented a particular challenge to the chemist because of the important role of vitamins in nutrition. As a result of intensive research the major vitamins have been identified chemically and made synthetically. The chemical manufacturer has been especially interested in vitamins because of the possibility of a large return from the production of relatively small quantities.

Vitamin C or ascorbic acid was once a scarce item in many diets because it is found in only a limited number of foods and is easily destroyed by cooking and by inadequate methods of food storage or preservation. The absence of this vitamin leads to scurvy, once a common affliction among persons of restricted diet, particularly in winter. The production of ascorbic acid in 1957 was 3,429,000 pounds. This output would provide a 25-milligram tablet for

[3] "Lysine prospects brighten," Staff article, Chemical and Engineering News, p. 25, April 20, 1959.

every person in the United States every day of the year. The wholesale price, $4.76 per pound, is equivalent to one-fortieth of a cent for a 25-milligram tablet. This is far below the price of citrus fruit or other foods containing the same amount of ascorbic acid.

Other vitamins, likewise, are produced in quantity. The 1957 output was 7,802,000 pounds, with an average price of $12.18 per pound. As an indication of the price range niacin at $2.42 per pound may be compared with vitamin B_{12} at $22,500 per pound. The high price of vitamin B_{12} is offset by the fact that the daily dose is only 1 microgram costing 0.005 cent.

It is ironical that the production and consumption of vitamins should be so high in the United States where there is such an abundant supply of adequate natural foods that some authorities regard much of the current use of vitamin supplements as unnecessary. However, if synthetic vitamins have made a contribution to the well-being of the American people, certainly the large scale production and use of vitamins elsewhere in the world would make an even greater contribution to the health and well being of many peoples having a much more restricted food supply.

Minerals. The minerals required for nutrition can, with a few important exceptions, be readily utilized by the body if supplied in inorganic form. Some animals are capable of producing their own supply of vitamin B_{12} if cobalt is fed in the form of an inorganic salt. However, the human body is not able to do this.

Mineral supplements such as those containing calcium, iron, and occasionally other elements are rather commonly added to bread made from white flour to replace elements lost in milling. Mineral supplements are regularly added to prepared feed for animals since the amounts normally present in grain and other constituents may not be adequate for optimum growth.

Colors and Flavors. Colors and flavors contribute little if anything to the nutritional value of foods but they add a great deal to the pleasure of eating. A very significant proportion of the colors and flavors used in the food processing industries, as well as those sold at retail, are manufactured by synthesis because they can be thus produced in far greater variety and more cheaply than from the natural products. The 1957 production of colors and flavors was 45,294,000 pounds, with an average price of $1.38 per pound. In other terms this output amounts to about 4 ounces per year for each person in the United States. Natural flavors usually consist of a major constituent with a variety of minor constituents, whereas the synthetic flavor may consist of a single, pure substance. The principal constituent of vanilla extract is vanillin. The artificial extract made from pure vanillin can be distinguished by some but not all persons from the natural product. To duplicate natural vanilla or any other natural flavor it would be necessary to identify, synthesize, and add the minor constituents.

The color and flavor industry is by no means confined to the duplication or imitation of natural products; the soft drink industry affords an illustration of the almost endless variety of colors and flavors that can be made which never occurred in nature.

Food Synthesis and the Present Chemical Industry

The order of magnitude of the task of synthesizing food for the world's increasing population can be estimated by comparing the additional amount of food that will be required with the present output of the synthetic organic chemical industry in the United States. According to estimate by the United Nations the world population will increase at the rate of about 53 million people a year between 1950 and 1975. Assuming that food for all 53 million persons is to be produced by synthesis at the rate of 500 pounds on a dry basis per person per year, the amount required would be 26,500 million pounds per year. In 1957 the sales of synthetic organic chemicals produced in the United

States amounted to 21,696 million pounds, valued at $5,367 million. Thus, to enable synthetic food to keep pace with the increase in population, the problem would be that of constructing each year plant and facilities for producing a quantity of amino acids, carbohydrates, fats, vitamins, and other materials only a little greater than the total output of the American synthetic organic chemical industry. The problem, however, would not be nearly as great as would be the duplication of the present industry because only a small number of items would be produced on the largest practical scale, whereas the present manufacture of organic chemicals involves the production of many thousand items, the majority of which are made on a small scale. But even with much of the production on a small scale, the average value of the synthetic organic chemicals produced in 1957 was only 25 cents per pound. If food products could be made at this price the 500 pounds required per person per year would cost only $125 at wholesale.

The capital outlay for plant and facilities can be estimated roughly by assuming a figure for the cost per pound of production per year. This figure would vary greatly with the items to be produced, the labor and materials available in the different countries, and the degree to which the processes had been developed to achieve maximum efficiency. Assuming a figure of $0.50 per pound per year, an annual investment of the order of $13,000 million would be required to step up synthetic food production so as to keep pace with the population during the next few years. This investment is about seven time the $1,775 million that was invested in 1957 by the American chemical industry for making chemicals of all kinds. On a world-wide basis this amount is small in comparison with military expenditures and lies within the realm of achievement. Certainly it would be a small price to pay if it would forestall major conflicts that might otherwise arise from population pressure.

Acceptance of Synthetic Foods

The acceptance by the American public of synthetic food products is an accomplished fact so far as vitamins, colors, flavors, and supplements to processed foods are concerned. The acceptance of completely synthetic foods, however, may present problems because of the conservatism of most people with regard to food habits, in addition to the prejudice in many quarters against anything that may be regarded as "chemical" or synthetic. To aid in overcoming objections the synthetic food materials can be produced in any desired texture,—soft, hard, brittle, plastic, tough, and even fibrous. There need be only an extension of the techniques already exploited by the breakfast food manufacturers. Natural flavors can be duplicated and a wide range of intriguing new flavors can be created.

Opposition is to be expected particularly from food faddists who base their practices on the long outmoded vitalistic theory that materials produced by plants or animals are inherently different from those obtained from non-living sources. Any such difference has, of course, been disproved by research over the last 150 years, but the lag in the general acceptance of scientific information is such that the vitalistic theory still has many vigorous champions.

One popular misunderstanding that is to be expected is that the synthetic foods will be produced in the form of pills in which the food is so highly concentrated that a few of the pills will constitute a day's ration. Facetious and serious references to such pills were added to some of the accounts of this address which have appeared in the daily press.

The acceptance of synthetic foods can be brought about most simply by the gradual extension of present practices of adding essential synthetic ingredients as supplements to agricultural food products that are known to be inadequate in themselves, such as white bread in the West and polished rice in the East. Public education coupled with the first hand experience of improved health and well-being will serve to minimize and ultimately to dissipate completely any problems with regard to acceptance.

Conclusion

The synthesis of food offers a solution of the problem of feeding the world's rapidly increasing population that is within the realm of practicality. The technical manpower and the capital outlay required to develop large-scale methods of manufacture and to construct the initial facilities would be large in comparison with most civilian manufacturing operations but would be small in comparison with the cost of military preparedness or a small war. Once the methods of production were fully developed they would be practical for utilization in even the now backward countries where the greatest population pressures are developing.

In the immediate future synthetic production could most profitably be devoted to materials designed to supplement those foods that can be produced by agriculture most economically and in the largest yields. Beginnings have already been made in the production and use of synthetic vitamins and amino acids as supplements to grains and other relatively abundant agricultural products, particularly for the feeding of animals. The use of these supplements could be extended so as to replace the less economical foods of animal origin. The signal advances that have been made in animal nutrition could be extended to human nutrition with a correspondingly great improvement in growth, health, and general well-being.

In the longer range, with continued population pressure, synthetic production could be extended beyond the supplements to provide the major foods themselves, including all of the essential amino acids, the fats, the carbohydrates, and the vitamins.

The history of synthetic organic chemistry shows clearly that synthetic foods can and undoubtedly will ultimately be developed to the stage at which they can be produced in such large quantities and at so small an expenditure of human effort that they will replace agriculture, just as agriculture replaced the hunting of game animals and the gathering of wild plants for food.

Such a development would permit a very great increase in the population of the earth, and at the same time would enable the population to be distributed in such a way as to avoid crowding. The consequent changes in the entire pattern of living would mark a new era as different from the present as the city of Jarmo was different from the cave of Shanidar.

Acknowledgment

The author gratefully acknowledges advice and assistance from Aaron M. Altschul, Augustus R. Glasgow, Clem O. Miller, Ralph S. Solecki, Neil W. Stuart, Francis Joseph Weiss, and other colleagues who have read this paper and offered helpful suggestions and comments.

Ed. Note: Page charges for excess material (above 8 pgs.) have been honored by the author.

Other Academies

Lawrence A. Wood

Following my recent installation as President of the Washington Academy of Sciences I thought that it would be fitting to find out just what an academy might be. The encyclopedia quickly led me back to an olive grove in a pleasure garden about a mile outside the walls of Athens, where Plato discoursed and founded a school of philosophic thought that continued to flourish for more than nine hundred years. In modern times, the encyclopedia continues, the word academy has come to denote a society having for its object the cultivation and promotion of science, art, or literature for the pure love of these pursuits. The first academy of science,

founded in Naples in 1560, was the Academia Secretorum Naturae, and membership was conferred only on those who had made some discovery in natural science. Its establishment must have been premature, for its founder, although acquitted on charges of practicing black magic, was ordered to close the academy. Various natonal or local academies devoted to science founded in the seventeenth century continue to this day. Our own organization does not conform to a general rule laid down in the encyclopedia to the effect that modern academies have almost without exception some form of public support in being either founded, endowed, or subsidized by a national or local government.

In this country our academy is a member of a federation called The Academy Conference of the A.A.A.S., which includes 35 academies of science bearing state names, 3 bearing regional names, and 5 bearing city names. Other well-known academies not affiliated with the Academy Conference are the American Philosophical Society of Philadelphia (1743), the American Academy of Arts and Sciences of Boston (1780), and the New York Academy of Sciences (1817).

The range of activities of these academies of science is very great and strongly reflects local conditions. Many of the state academies have only a general meeting once a year with the place of meeting rotating among the colleges and universities of the state. Many of the others sponsor more frequent meetings on specialized topics. The New York Academy of Sciences, for example, may have a dozen or more divisional meetings each month. Junior academies of science and other activities in secondary schools are often sponsored by the academies, some of them receiving grants for these purposes from the National Science Foundation. Collegiate sections for undergraduates are maintained by some academies. Some of the academies give annual awards of various sorts. Many of them publish journals or "proceedings" of varying content.

The most ambitious programs of academies include the ownership and operation of museums of science or natural history, planetaria, aquaria, libraries, etc., as well as the sponsorship of field expeditions, weekly television programs, and other activities. Only a few academies, located in large cities, find it possible to engage in activities of this sort, Some of the work of this type is supported by the income from endownments; other academies receive grants or other benefits directly from a state or city government.

In many ways the Washington Academy of Sciences is similar to other academies representing a state or a large city. The major difference from most of them lies in our activities as a federation of the local sections of the 27 affiliated societies.

Founded in 1898 the Washington Academy of Sciences has developed slowly over the years. In the past twenty years, during which I have been in a position to observe the Academy, the changes in the organization have been too few and too limited to reflect properly the tremendous growth of scientific activity in the Washington area and the emergence of our city as one of the outstanding world centers of scientific research. The present officers will be deeply appreciative of suggestions from the members and affiliated societies as to steps by which the Academy can increase its effectiveness and begin to assume again a more important position of leadership in the scientific life of the Nation's Capital.

E, S, and A Day

E S and A Day, as it is called colloquially, is the most publicized contribution of the DC Council of Engineers and Architectural Societies to the encouragement of education leading to careers in engineering, science, and architecture. When this local, annual event was first staged five years ago, it was called E and A Day and was limited to engineering and architecture and to education underlying these professions. Two years ago the cooperation of the Washington Academy of Sciences was sought, and S, for science, was added to E and A Day. But the work required to prepare for E S and A Day is still done by members of the DC Council and credit for it belongs to that organization.

E S and A Day attempts to accomplish its mission by turning a public spotlight for a half day each year on noted engineers, scientists, and architects and their work, and on dedicated secondary-school teachers who might otherwise remain in obscurity. But its impact is not limited to the effect of the program of the Day on its audience. Preparation for the Day is a highly organized effort that goes on for months preceding the event, and the process of seeking financial support for it, of obtaining nominations of outstanding teachers, engineers, scientists, and architects for awards, of advertising the Day and selling tickets to the luncheon—all this probably makes an impression on more people than does the Day itself.

On February 25, 1960, the featured event of the Day was a luncheon that more than seven hundred people attended at the Presidential Arms, 1320 G Street, N.W. The ballroom floor and a mezzanine floor above one side of it were crowded with circular or rectangular tables, each seating eight. The tables along the mezzanine railing faced an elevated head table on the other side of the floor below. There ten persons were seated: G. R. Tatum, General Chairman; Joseph L. Gillman, Jr., Toastmaster; Ralph I. Cole, Chairman, DC Council; Lawrence A. Wood, President, Washington Academy of Sciences; the featured after-luncheon speaker James A. Van Allen; and the members of the morning symposium on "Space"; i.e., Thomas J. Killian, Herbert Friedman, C. F. Gell, Paul A. Goettelman, and Hugh L. Dryden. In front of the head table and at a lower level was a longer table seating at its center those who were to receive the National Capital Awards in engineering, science, and architecture; i.e., Thorndike Saville, Jr., M. Lee Rice, and Anthony T. Zaia, respectively. On either side of them were places for six teachers: Mrs. Sarah B. Adams, Mrs. Edith M. Allen, Mrs. Virginia W. Biedler, Mrs. Edith L. Carter, Mrs. Helen N. Cooper, Mrs. Pauline Desmond, Mr. Thomas P. Hillman, Mr. Charles Kilbourne, Mr. Howard E. Kerr, Miss Johanna B. Kirstein, Dr. Bernice G. Lamberton, and Miss Katherine Shiels. By each of these twelve plates was placed a one-volume encyclopedia of science as a gift to the recipient of a Science Teacher's Award. Other nominees for awards were named in the program. The teachers were seated in the audience as guests of the Joint Board on Science Education. Very few members of the Washington Academy were present.

The presentation of awards to those named above preceded the address by James A. Van Allen on the "Radiation Environment of the Earth." Dr. Van Allen directed the design and assembly of instruments in Explorer I that detected around the earth radiation belts now named after him. It is well known that he is head of the Department of Physics at the State University of Iowa and that he played a leading role in the US earth satellite program before and during the International Geophysical Year, but it is not as well known as it should be here in Washington that for almost a decade he was a worker in the Washington scientific community and was a member of the Washing-

ton Academy of Sciences. From 1939 to 1942 he was a research fellow in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. During World War II he served as Lieutenant Commander in the Navy, ordnance and gunnery specialist and combat observer. After the war he returned to Washington and worked in the Applied Physics Laboratory, Johns Hopkins University, until he went to Iowa in 1951. In January 1949, when he was 34 years old, he received from the Washington Academy of Sciences its annual award for 1948 in the physical sciences "for his work in nuclear physics and cosmic rays." In April 1959 he was elected a member of the National Academy of Sciences.

Dr. Van Allen gave a long illustrated lecture on the methods and results of his investigations of the radiation environment of the earth. His slides gave his audience some appreciation of the complexity of the instrumental packages, or payloads, that were carried by five of our space vehicles. Results were shown in the form of graphs and maps of the radiation zones. At the end he touched on the biological effects of radiation found in these zones.

Science in Washington

SCIENTISTS IN THE NEWS

This column will present brief items concerning the activities of members of the Academy. Such items may include notices of talks given, important conferences or visits, promotions, awards, election to membership or office in scientific and technical societies, appointment to technical committees, civic activities, and marriages, births, and other family news. Formal contributors are being assigned for the systematic collection of news at institutions employing considerable numbers of Academy members (see list on masthead). However, for the bulk of the membership, we must rely on individuals to send us news concerning themselves and their friends. Contributions may be addressed to **S. B. Detwiler, Jr., Associate Editor, 2605 S. 8th St., Arlington, Va.**

APPLIED PHYSICS LABORATORY

Ralph E. Gibson was guest of honor and speaker at the annual dinner of the Cleveland Chapter, National Defense Transportation Association, on January 14.

Alfred J. Zmuda has been appointed a consultant to the Geophysics Panel of the Air Force Scientific Advisory Board. A paper by Dr. Zmuda entitled, "Some Characteristics of the Upper-Air Magnetic Field and Ionospheric Currents," appeared in the January issue of the *Journal of Geophysical Research.*

CATHOLIC UNIVERSITY

Frank A. Biberstein, Jr., professor of civil engineering, has been appointed chairman of ASTM Subcommittees III (Concrete and Sand Lime Units) and XI (Editorial).

Henry P. Ward, professor of chemistry, participated in a Summary Conference on Chemistry Teaching in the Washington Area, held at American Chemical Society headquarters on February 13.

COAST AND GEODETIC SURVEY

David G. Knapp received the Department of Commerce Meritorious Service Award on February 18, for unusual contributions to highly technical areas of the C&GS Geomagnetic Program.

Dean S. Carder spent most of February in Los Angeles as technical adviser to AEC on its current series of "Cowboy" experiments.

The Franklin Institute has awarded its Boyden Premium to **Carl I. Aslakson** "in consideration of his contribution to the measurement of the speed or radiation in space through the use of Shoran techniques and thereby as the first American to aid in establishing a new and significantly more nearly accurate value of 16 km per second higher than the long-accepted value." Captain Aslakson was expected to receive this award, which involves a cash payment of $500, at ceremonies in Philadelphia on March 16. The Boyden Premium, established in 1859, has been awarded on only two previous occasions.

GEORGE WASHINGTON UNIVERSITY

Mary L. Robbins has been appointed to an Educational Advisory Committee for a conference to be sponsored by the Women's Bureau of the Labor Department, in commemoration of its 40th anniversary next June.

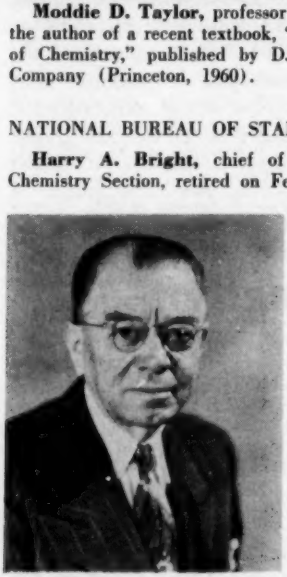
HOWARD UNIVERSITY

Lloyd N. Ferguson, professor and head of the Chemistry Department, served as visiting scientist at Hamlin University, St. Paul, Minn., February 8-10. The Visiting Scientist Program is sponsored by the American Chemical Society's Division of Chemical Education.

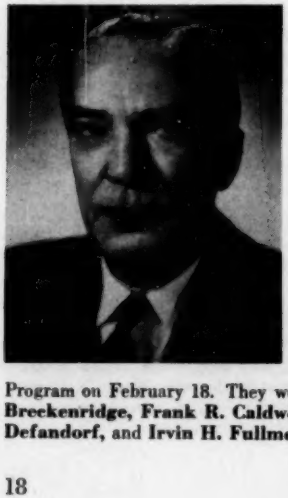
Moddie D. Taylor, professor of chemistry, is the author of a recent textbook, "First Principles of Chemistry," published by D. Van Nostrand Company (Princeton, 1960).

NATIONAL BUREAU OF STANDARDS

Harry A. Bright, chief of the Analytical Chemistry Section, retired on February 29 after almost 47 years of service in the Chemistry Division. Members of the staff and other friends gathered at the Senior Lunch Club to wish him well on his retirement, and to congratulate him for winning the 1960 Anachem Award for Outstanding Achievement in Analytical Chemistry.



Benjamin L. Page has been appointed chief of the Length Section, Optics and Meteorology Division, effective January 24. Mr. Page had been acting chief of the Section since March 1959.



Fourteen NBS Staff members were honored by the Department of Commerce at its Twelfth Annual Honor Awards Program on February 18. They were: **Francis C. Breckenridge, Frank R. Caldwell, Francis M. Defandorf,** and **Irvin H. Fullmer,** who received two-point diamond pins on solid gold and blue enamel emblems, in recognition of 40 years of excellent service; **Garbis H. Keulegan, Alvin G. McNish, Chester H. Page, Charlotte M. Sitterly, Herbert P. Broida,** and **Arnold M. Bass,** who received gold medals for exceptional service; and **Hugh Logan, Benjamin L. Page, John K. Taylor,** and **John Wachtman, Jr.,** who received medals for meritorious service.

On February 19, **Samuel N. Alexander** addressed the Philosophical Society of Washington on "World Wide Activities in Computing and Data Processing Technology."

John A. Bennett spoke on "Fatigue Fracture" at the Seminar on Mechanics of Fracture in Metals, held in Windsor, Conn., by the Hartford Chapter of the American Society of Metals.

A paper on "Deposition of Tungsten Coatings from Fused Salt Baths and from the Gas Phase" was presented by **Abner Brenner** on January 19 at MIT.

Florence H. Forziati has been elected secretary of the Washington Section of the American Association of Textile Chemists and Colorists.

Hans P. R. Frederikse spoke on "Properties of Titanium Dioxide" at the General Electric Research Laboratory, Schenectady, on February 19.

Walter J. Hamer presented a paper on "Aircraft Storage Batteries" before the American Institute of Electrical Engineers in New York City, February 1, and a paper on "New Developments in Batteries" at the regional meeting of the American Transit Association in Washington, on February 9.

Archibald T. McPherson, associate director for engineering, spoke on "Recent Developments in Standards" before the American Society for Quality Control at Parkersburg, W.Va., on January 20.

Aaron S. Posner has been appointed to serve on the Advisory Editorial Board of the *Journal of Dental Research.*

Bourdon F. Scribner attended the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, February 29 to March 4, and presented a paper on "Relative Intensities for the Arc Spectra of Seventy Elements."

On January 22, **James L. Thomas** participated in the dedication of a new laboratory of the Arma Corporation at Garden City, N.Y., and reviewed "The State-of-the-Art in Electrical Standards".

NATIONAL INSTITUTES OF HEALTH

Sara E. Branham, currently participating in the visiting biologist program of the American Institute of Biological Sciences, has been named Medical Woman of the Year by the Washington, D.C., branch of the American Medical Women's Association. She retired as chief of the section

on bacterial toxins at the National Institutes of Health last July, after 30 years of work for the Public Health Service.

NAVAL RESEARCH LABORATORY

Richard L. Dolecek, superintendent of the Solid State Division, represented NRL at the Fourth Navy Scientific Symposium, entitled "Naval Problems in Electromagnetic Radiation," which was held in Pasadena, Calif., March 9-11. Dr. Dolecek is well known for his pioneering work on the entropy of superconductors and his role in the prediction of the isotope effect in superconductors.

William A. Zisman addressed the Chicago Section of the American Chemical Society on February 18. His topic was, "Wetting and Surface Constitution."

Herbert Friedman presented an invited talk, "X-ray Absorption Edge Spectroscopy," at the Norelco Eastern X-ray Spectroscopy School, New York, on February 18. On February 28 Dr. Friedman appeared as a guest on Johns Hopkins' File 7 television program, "A New Look at the Universe." He presented the story of rocket astronomy and reported on the latest developments in this field.

L. S. Birks, head of the X-ray Optics Branch, Optics Division, is author of a new book, "X-ray Spectrochemical Analysis" (Interscience Publishers, New York). This is Volume XI of "Chemical Analysis," a series of monographs on analytical chemistry and its application.

USDA, BELTSVILLE

Clarence H. Hoffman spoke on "Recent Advances in Entomology" on January 13, before the 37th Annual Meeting of the Pennsylvania Entomological Society at Harrisburg, Pa. On January 26 Dr. Hoffman presented a paper, "Insecticide Residues on Fruits, Vegetables, and Forage," at a symposium on chemical residues in agriculture held in East Lansing under the sponsorship of the Michigan Department of Agriculture and the Michigan AES. And on February 4 he presented a paper, "Aerial Applications of Insecticides in Relation to Fish and Wildlife," at the 9th Annual Nebraska Aerial Applicators Short Course, held in Norfolk, Neb.

Edward F. Knipling, director of the Entomology Research Division, Agricultural Research Service, was one of five scientists selected to receive the *Progressive Farmer* 1959 "Men of the Year" award. Dr. Knipling originated the idea of releasing sexually sterile males as a means of controlling or eradicating insect populations. The five scientists played a vital role in the development and application of this principle for the eradication of the screw-worm, an important insect pest, from the southeastern United States.

The possibilities of applying the sterile male method to control other insects and higher animal pests was discussed by Dr. Knipling in the October, 1959, issue of *Science*.

Frank P. Cullinan, associate director of the Crops Research Division, Agricultural Research Service, has been elected president of the Scientific Manpower Commission for the calendar year 1960.

USDA, WASHINGTON

Elbert L. Little, Jr., dendrologist with the Forest Service, has accepted the position of visiting professor of dendrology at the spring term of the Forestry School, University of the Andes, at Merida, Venezuela. He held the same position in 1953-54.

Harold T. Cook and **Herbert L. Haller** served on a USDA team that negotiated agricultural research grants and surveyed research institutions in Poland, Finland, Spain, France, Italy, Yugoslavia, and Israel during the last three months of 1959. The trip was undertaken in connection with the foreign research program that is being conducted under Public Law 480 and financed with funds received from sales of surplus farm products.

Harold H. Shepard is the editor of Volume II of "Methods of Testing Chemical on Insects," recently issued by Burgess Publishing Company of Minneapolis. The book includes techniques for the selection of effective insecticides, attractants, and repellents, with special attention to the factors affecting experimental results. Individual chapters are devoted to such subjects as the handling of spider mites, systemic chemical control of internal pests of livestock, etc.

Among other activities, **Ashley B. Gurney** of the Entomology Research Division is working on a taxonomic study of the Blattoidea (cockroaches) of the Philippines, Formosa, and Japan. This work is being done in collaboration with K. Princis of Lund, Sweden, who is coming to the U.S.A. under an NSF grant administered by the Smithsonian Institution.

UNIVERSITY OF MARYLAND

S. Fred Singer spoke at a convocation of the College of Arts and Sciences on February 25, on the topic, "Rockets and Outer Space." This was the first of what the College hopes will be a regular series of convocations, at which faculty members returning from sabbatical leaves can report on their activities.

DEATHS

William D. Urry, an active resident member since 1941, died of a coronary occlusion on December 16, at his home in Bethesda. Dr. Urry had been employed by the Air Force.

AFFILIATED SOCIETIES

American Institute of Electrical Engineers, Washington Section

Chairman: Wade M. Edmunds (REA). *Secretary-Treasurer:* Irvin L. Cooter (NBS).

April 26, "Power and Communications Problems in the Design and Construction of Dulles International Airport," Herbert H. Howell, Federal Aviation Agency.

May 24, program of technical papers in electrical engineering.

American Society for Metals, Washington Chapter

President: William L. Holshouser (NBS). *Secretary:* Glenn W. Geil (NBS).

April 18, "Titanium and Competitive Stainless Steels," Walter L. Finaly, Crucible Steel Company.

May 16, National Officers Night, featuring address by the National President, Walter Crafts, on "Facing the Productivity Challenge: Men and Metals of the Next Decade." This meeting will be at the Officers Club, Naval Weapons Plant and not at the All States Restaurant.

American Society of Mechanical Engineers, Washington Section

Chairman: Alfred F. Bochenek (Bit. Coal Inst.) *Secretary:* Virgil L. Pence.

April 20, annual banquet, Terrace Dining Room, Arlington Towers; speaker will be W. H. Upson, writer and lecturer; music by a Navy choral group; presentation of awards to local section members by the President of ASME, Walker Cisler.

Anthropological Society of Washington

President: Harvey Moore (AU). *Secretary:* Frank Anderson (U.Md.).
Meetings on third Tuesday, except June-Sept., Room 43, Museum of Natural History, at 8:15 P.M.

March 22, "Culture Change Among the Utes," Dr. Gottfried Lang, Catholic University.

Botanical Society of Washington

President: Harold T. Cook (USDA). *Corresponding Secretary:* Muriel J. O'Brien (USDA).
Meetings on first Tuesday, John Wesley Powell Auditorium, 8:00 P.M.

Columbia Historical Society

President: Maj. Gen. U. S. Grant, 3rd. *Executive Secretary:* John T. Gibbs.

April 14, "History of the Cosmos Club," Paul H. Oehser; meeting at Heurich Memorial Mansion.

May 14, "The Friday Morning Music Club, a Record of 75 Years," Mrs. Frank P. Howard; meeting at Heurich Mansion, musical program and exhibit of sheet music.

Entomological Society of Washington

President: Paul W. Oman (USDA). *Corresponding Secretary:* Paul Woke.
Meetings on first Thursday, October to June, Room 43, National Museum.

Insecticide Society of Washington

President: Milton S. Schechter (USDA). *Secretary-Treasurer:* James F. Cooper (USDA).
Meetings on third Wednesday, Oct., Nov., Jan.-May, in Symons Hall Auditorium, U. Md., at 8:00 P.M.

Institute of the Aeronautical Sciences, Washington Section

Chairman: B. C. Myers II (NASA). *Secretary:* Harold Andrews.
Meetings usually on the second Tuesday of each month, at the International Room, Occidental Restaurant.

Philosophical Society of Washington

President: Louis R. Maxwell (NOL). *Secretary:* F. N. Frenkiel (DTMB).
Meetings held on alternate Fridays, John Wesley Powell Auditorium.

Society for Experimental Biology and Medicine, District of Columbia Section

President: George A. Hottle (NIH). *Secretary:* Edwin P. Laug (FDA).

April 7, meetings in Hall A, G. W. Univ. School of Medicine, 1335 H. St., N.W.

Society of American Bacteriologists, Washington Branch

President: Mary L. Robbins (GWU). *Secretary:* Elizabeth J. Oswald (FDA).
Meetings on the fourth Tuesday, Oct., Jan.- April, and sometimes May, at Walter Reed Army Medical Center, 8:00 P.M.

At its meeting on January 26, the members unanimously approved a series of recommendations prepared by its Executive Committee, reaffirming its support of the idea of the Science Fairs, but urging that: (1) preparation of a project for entry not be required as part of a formal course; (2) that no form of pressure be applied to induce students to prepare a project for competition; (3) that the project be prepared entirely in the home or school; (4) that major equipment used be made and assembled by the student, not borrowed from a scientific institution; (5) that a realistic limit be placed on the amount to be spent on project materials; (6) that the use of pathogenic organisms be prohibited; (7) that the student's advisor be notified

of the rules of the Science Fairs. These recommendations are being sent to appropriate organizations in the Washington area for consideration.

Society of American Foresters, Washington Section

President: James M. Owens (Dept. Commerce). *Secretary:* Matt C. Huppuch (Dept. Army). Meetings usually on third Thursday, during the winter season, at the YWCA.

No meeting in April.

The Fifth World Forestry Congress, first to be held in the Western Hemisphere, will be in Seattle, Washington, August 29-September 10, 1960.

The 60th Anniversary, Society of American Foresters, will be held in Washington, November 13-16, at Sheraton Park, with Arthur Greeley (USFS) serving as General Chairman.

Society of American Military Engineers, Washington Post

Secretary: Col. Robert P. Tabb, Jr. Meetings on third Monday, each month, at 12:15 for luncheon at Y.W.C.A.

Chemical Society of Washington

President: Allen L. Alexander (NRL). *Secretary:* John L. Torgesen (NBS).

The Board of Managers met on February 11 at Caruso's Italian Kitchens, with Pres. A. L. Alexander presiding. The officers of the Washington Junior Academy of Sciences were present as guests.

In a discussion of responsibilities of the Awards Committee it was suggested that the Committee consider nominations of members for awards other than those sponsored by the American Chemical Society.

Dr. Alexander read a letter from President Elkins of the University of Maryland, expressing appreciation to the Chemical Society for its interest in a suitable memorial to the late Nathan L. Drake. The letter stated that a new building adjacent ot the Chemistry Building will be named the Nathan L. Drake Lecture Halls, and that an appropriate plaque will be erected therein.

President-elect W. J. Bailey reported that a comprehensive annual report of the secretary for 1959 had been completed and forwarded to ACS headquarters. Several copies of the report are available for circulation among the membership of the Society. Dr. Bailey pointed out several little-known items of interest in the report: (1) numerous local section members serve in national offices; (2) as many local section members serve as councilors of ACS divisions as serve on the general ACS Council; (3) attendance at general meetings of CSW has averaged only 5 percent of the total membership.

The 696th general meeting of the Society was held on February 11 in the auditorium of the Museum of Natural History. This was a joint meeting with the Washington Junior Academy of Sciences. James H. Schulman, associate superintendent of the Solid State Division, Naval Research Laboratory, presented a lecture demonstration on "Crystals: A Study in Order and Confusion."

ACADEMY ACTIVITIES

Board of Managers, January Meeting

These notes are intended to outline briefly, for the information of the membership, the principal actions taken at Board meetings. They are not the offlcial Minutes as prepared by the Secretary. —Ed.

The Board of Managers held its 525th meeting of January 19 at NAS, with President Campbell presiding.

For the Committee on Meetings, Dr. Campbell reported on arrangements for the dinner meeting of the Academy on January 19, and on the meeting of February 18, at which he will give the address of the retiring president.

On behalf of Chairman Van Evera of the Committee on Grant-in-aid for Research, Dr. Campbell reported on the application of a Fairfax High School student for a $45 grant, to be used in buying equipment for a science project. The Board provisionally accepted the application, subject to receipt of Dean Van Evera's formal recommendation.

Chairman Schubert of the Committee on Encouragement of Science Talent reported on the first Science Convention of the Washington Junior Academy of Sciences, held December 28 at the Burlington Hotel. About three dozen papers based upon original work were presented before an audience of 150 persons; this attendance comprised somewhat more than a third of the membership of WJAS (see list of papers in Jan. issue).

Dr. Schubert also reported on activities of a committee on research opportunities for high school students, which is arranging for some 20 students to work at Government laboratories during the summer. John M. Leonard of the Naval Research Laboratory is chairman of the committee. It is expected that a fund of $1600 will be available to provide transportation and lunches for the students; of this amount, $1,000 is being provided by WJAS, $300 by the Chemical Society of Washington, and $300 by the senior Academy.

The treasurer questioned whether the WAS Board had specifically authorized appropriation of $300 for the foregoing purpose; it was left that the secretary would check the Minutes of

previous meetings to determine what action had been taken.

For the Special Committee on Bylaws, Dr. Specht reported that the next action on the revised Bylaws (approved by the Board at its meeting of December 15) is to put them into form for consideration and approval by the Academy membership. In the version that is to be sent out, proposed changes will be indicated.

Dr. Campbell recommended that this committee be continued in operation during 1960, until action could be taken on a revision of the Standing Rules.

The Board took note that the new 1959 Directory had just been issued and was being mailed out to the membership.

Dr. Campbell suggested that incoming President Wood consider the appointment of a special committee on science in the proposed National Cultural Center. He felt that the Center might be used for international scientific congresses, or large national scientific meetings.

Dr. Campbell observed that the administrative secretary of WAS is bearing the burden of compiling and distributing the Science Calendar. He felt that the Joint Committee on Press Relations should be reactivated to direct this and other public relations activities.

Chairman Kushner of the Membership Committee presented for second reading the names of seven candidates previously proposed for Academy membership, as follows: Seymour L. Friess, Sydney Geltman, William A. Geyger, Samuel K. Love, Raymond L. Nace, Bertram stiller, and Madelyn Womack. These candidates were then elected to membership.

Dr. Specht reported that as of January 15 the Academy had 765 regular resident members, 61 retired residents, 191 regular non-residents, 60 retired non-residents, and 6 others, for a total membership of 1083. This represents a net increase of 17 over last year's total.

Dr. Specht reported the results of the recent referendum on the preferences of the membership on the future content of the *Journal*. The majority was clearly in favor of including news of the Academy and local scientific activities, as well as original scientific articles.

Dr. Brombacher presented the treasurer's financial report for 1959. This showed a total income of $14,550 and expenses of $18,743, giving a deficit of $4,193. The value of investments decreased from $70,219 to $70,098.

Dr. Rehder, custodian of publications, reported that the Smithsonian Institution needed the room in which Academy publications are kept, and that he is hoping to find space at the Carnegie Institution.

Board of Managers, February Meeting

The Board of Managers held its 526th meeting on February 16 at NBS, with incoming President Wood presiding.

The minutes of the 525th meeting were approved with minor corrections.

Dr. Wood announced the names of such 1960 committee chairmen as had so far been appointed. (See list elsewhere in this issue.)

The Board confirmed the appointment of an editor, a managing editor, and four associate editors of the *Journal*. (See list on masthead.)

The 1960 budget was presented by Treasurer Aslakson and discussed. This showed estimated receipts of $12,900, including $5,500 from dues, $2,000 from *Journal* subscriptions, $1,000 from sales of back issues of the *Journal*, and $3,500 from interest and dividends; and estimated expenditures of $13,560, including $4,000 for printing the *Journal*, $5,515 for the headquarters office, and $1,000 for the secretary's office. The budget was passed with the proviso that an item be included under Receipts to show that the $660 deficit was being offset by a withdrawal from reserve funds.

Dr. Wood presented a recommendation of the Executive Committee, that $300 be appropriated —as an unbudgeted item—to the Committee on Encouragement of Science Talent to defray transportation and lunch expenses for high school science students who will conduct research studies at NIH during the summer; these funds are to be supplemented by $1,000 from the Junior Academy and $300 from the Chemical Society. The recommendation was approved.

Chairman Hall of the Membership Committee presented for first reading the names of two candidates for membership. There were no candidates for second reading.

Chairman Schubert of the Committee on Encouragement of Science Talent discussed an aspect of the March meeting of the Academy, which will be a joint meeting with the Junior Academy. At this meeting some 25 winners of the Science Talent Search will be present as dinner guests. Dr. Schubert indicated that in the past, the cost of meals for the guests had been personally defrayed by Committee members; but that the affair had grown to such an extent that some relief was needed.

There was extended discussion of the wisdom of using Academy funds for the indicated purpose. The matter was resolved by formal action appropriating $200 to the Committee for 1960, to spend as it sees fit. (Presumably this item is to be added to the budget.)

Dr. Schubert reported on plans to hold a national meeting of Junior Academies of Science next fall, for the discussion of common problems; for the conduct of this meeting, it is hoped to obtain an NSF grant of perhaps $30,000. Dr. Schubert moved that the Academy serve as one of the sponsors of the event, without financial obligation. The motion was passed.

In a discussion of the *Journal*, various members commented favorably on the new format and content of the January issue, and on the important part that the publication can begin to play in giving the membership a picture of Academy activities. On motion of Aurel O. Foster, the Board formally commended the editors for their maiden effort.

Dr. Wood read a letter from the Society of American Bacteriologists, suggesting the development of improved rules for Science Fair exhibits. It was recommended, for example, that preparation of an entry should be voluntary, and not a requirement of high school science courses; that pathogens should not be included in exhibits; and that exhibits should be self-made. The letter was referred for comment to the Committee on Encouragement of Science Talent, as a preliminary to referral by the Board of Managers to the Joint Board on Science Education.

JOINT BOARD

Local Teachers Honored on E S and A Day

The annual Engineers, Scientists, and Architects Day luncheon held at the Presidential Arms on Thursday, February 25 was the occasion for the presentation of Distinguished Teacher Awards to twelve local elementary, junior high, and senior high school teachers. In addition, seventy five others were presented Citations for outstanding teaching of science and mathematics in the local area schools.

Engineers, Scientists and Architects Day was established several years ago to honor and call attention of the public to the contributions of these professions to human progress. Each year distinguished members of these professions who have made outstanding contributions are singled out for recognition. Because of the prime importance of good teaching in technologic advancement, it seemed proper to honor outstanding teachers at the same time. Accordingly, the Distinguished Teaching Award was inaugurated by the Joint Board on Science Education in 1958. From nominations by school principals, twelve are selected for the award which consists of a Citation and a personalized copy of a scientific encyclopedia. Others are presented Certificates of Citation. All are honored guests of the Board at the luncheon.

Distinguished Teacher Awards were presented to Mrs. Sarah B. Adams, Calvin Coolidge H.S.; Mrs. Edith M. Allen, Burrville Elementary School; Mrs. Virginia W. Biedler, Randle Highlands Elementary School; Mrs. Edith L. Carter, Adelphi Elementary School; Mrs. Helen N. Cooper, North Bethesda Jr. H.S.; Mrs. Pauline Diamond, Sherwood H.S.; Mr. Thomas P. Hillman, Gunston Jr. H.S.; Mr. Charles Kilbourne, Suitland Sr. H.S.; Mr. Howard E. Kerr, Francis C. Hammond H.S.; Miss Johanna B. Kirstein, McLean H.S.; Dr. Berenice G. Lamberton, Paul Jr. H.S.; Miss Katharine Shields, Garfield Elementary School.

Certificates of Citation were presented to: Mrs. Dorothy Arnold, Tuckahoe Elem. S.; Mr. Alfred H. Benna, Newport Jr. H.S.; Sister Mary Bennet, Sacred Heart Academy; Mrs. Anita Bickford, Leland Jr. H.S.; Mrs. Ellen Bortz, Walter Johnson Jr. H.S.; Mrs. Catherine S. Bride, Takoma Park Jr. H.S.; Col. K. T. Brunsvold, St. Stephen's S.; Rev. Angus N. Carney, Archbishop Carroll H.S.; Mrs. Althea R. Carrick, Glenn Dale Elem. S.; Mrs. Lillian Casey, Bethesda Elem. S.; Sister M. Margaret Charles, Academy of the Holy Cross; Mrs. Elsie Covell, Annandale Elem. S.; Mrs. Madeline H. Curtis, Western H.S.; Mrs. Helen Dawson, Cynthia Warner S.; Mr. James R. Dietz, Mt. Rainier Jr. H.S.; Mr. William W. Duncan, Francis Jr. H.S.; Mrs. Sophia R. Edwards, Anacostia H.S.; Mrs. Margaret Eimer, Chesterbrook Elem. S.; Mrs. Lucille R. Foncannon, Mount Daniel Elem. S.; Miss Willye B. Freeman, Jackson Elem. S.; Mrs. Thelma L. Garrett, Hyattsville Jr. H.S.; Mr. James S. Gaskins, Luther Jackson H.S.; Miss Mattylen Gassett, Suitland Elem. S.; Mrs. Ruth S. Genzler, Rollingcrest Jr. H.S.; Mrs. Virginia M. Good, Eastern Jr. H.S.; Mrs. Alice B. Goode, Pine Crest Elem. S.; Mrs. Katharine M. H. Hammond, Falls Church H.S.; Mrs. Pamela G. Hanrahan, Oxon Hill H.S.; Mrs. Anna B. Hawes, Fairlington Elem. S.; Mrs. Francis L. Hiett, Jefferson S.

Mrs. Elizabeth S. Hill, Langston Elem. S.; Miss Ida W. Hill, Alice Deal Jr. H.S.; Mrs. Mildred D. Holloway, Neval Thomas Elem. S.; Mr. John H. Hoppe, Osbourn H.S.; Mrs. Juliette G. Hughes, Cardozo H.S.; Mr. Clarence L. Jackson, Shaw Jr. H.S.; Mr. Jerry Kenny, District Heights Elem. S.; Miss Ruth Kevin, National Cathedral S.; Lt. Col. Milford A. Koehler, Lee H.S.; Mr. Joseph Kulick, Stratford Jr. H.S.; Mrs. Mary E. Lacy, New Hampshire Estates Elem. S.; Mr. Duane Lamkin. J. E. B. Stuart H.S.; Mrs. Betty J. Long, Glenridge H.S.; Mrs. Emma M. Low, Westmore Elem. S.

Miss Gladys McCain, Williamsburg Jr. H.S.; Dr. Henry N. Merritt, Northwood H.S.; Miss Mary Lou Munsey, Freedom Hill Elem. S.; Miss Margaret R. Myerly, Laurel H.S.; Mrs. Alma R. Noble, Stanton Elem. S.; Mr. G. Franklin Padgett, Jefferson Jr. H.S.; Mrs. Marion H. E. Poole, Monroe Elem. S.; Mr. Thomas L. Poore, Lafayette Elem. S.; Mr. Dale E. Potts, Thomas Jefferson Jr. H.S.; Brother Robert, Ryken H.S.; Mr. Chester Rockwell, George Mason Jr.-Sr. H.S.; Mrs. Flora Ruffin, Banneker Jr. H.S.; Mr. Peter K. Schaffer, Herndon H.S.

Mr. Charles P. Scott, Wakefield H.S.; Mr. Harold Sheridan, Lynbrook Elem. S.; Mr. Robert

C. Sloop, Osbourn H.S.; Mr. Robert L. Smith, Highland Elem. S.; Mr. Harold Stein, Mt. Rainier Jr. H.S.; Miss Cecil Stiltz, Rock Creek Forest Elem. S.; Mrs. Veta M. Story, Woodley Hills Elem. S.; Mrs. Dorothy Svirbely, Regina H.S.; Mrs. Esther Swire, Thomas Jefferson Elem. S.; Mr. Frank K. Thomson, Blandensburg Sr. H.S.; Rev. Melvin Tracey, Mackin H.S.

Mrs. Rosalia J. Walters, Brightwood Elem. S.; Mr. Robert H. Weagly, Laurel H.S.; Mrs. Judith S. Wescott, Macfarland Jr. H.S.; Mr. Florent P. Westfall, La Plata H.S.; Mr. Howard S. White, Taft Jr. H.S.; Mrs. Sylvia S. White, Jennie Dean H.S.; Mrs. Thelma Whitehead, Banneker Jr. H.S.

JUNIOR ACADEMY

Reported by David Malin, Chairman Publications Comm. WJAS

Ten members of the Junior Academy were recently honored by the national Science Talent Search. One of them, Samuel R. Friedman of Woodrow Wilson High School, has been selected as one of the 40 national finalists. As a finalist, he will exhibit his research work in astronomy at a Washington exhibition early in March and will be eligible for scholarship awards.

Friedman's research project was entitled "An Analysis of Dark Markings On The North Equatorial Belt of Saturn". The markings were observed primarily through the National Capital Astronomers' five-inch refractor telescope on the Naval Observatory grounds and were analyzed for spatial frequency. The resulting frequency curves did not conform to theoretical expectation. Friedman theorizes that this may be due to optical illusion, or to the pattern of reflection from the planet's rings. He is now planning further work on this problem.

Other Junior Academy members who have been selected for the Science Talent Search honors group include the following high school seniors: Patricia Page, Anacostia, Kenneth D. Taylor, Anacostia, Steven Bollt, Bethesda-Chevy Chase, Cathy Briggs, Bethesda-Chevy Chase, Michael Brownstein, Northwestern, Frederick Moore, Richard Montgomery, Thomas Pike, Washington and Lee, Gilbert Fritz, Wakefield, and Frank Taylor, McLean. The research work of these winners will be published in the first issue of the Journal of the Junior Academy.

The research work of these area winners varied widely. For instance, Frederick Moore performed experiments on thermo-electric conduction, while Cathy Briggs made a study of Carotenoids and Vitamin A. Steve Bollt designed computer circuits and Gilbert Fritz designed a rocket system. Michael Brownstein presented a seismic model study.

The annual joint meeting of the WJAS with the Chemical Society of Washington was held on February 11. The main speaker was Dr. James Schulman of Naval Research Laboratory, who spoke on "Crystals: A Study in Order and Confusion". Dr. Schulman emphasized the development of our concepts of the crystal lattice on one hand, and such diversifying factors as dislocations, interstitial vacancies and impurities on the other.

During the program, the officers of the Junior Academy summarized the activities of this Fall and Winter. They stressed such achievements as the Science Convention, the publication of the Redbook, the Science Trips, and the closer relationship with the school science clubs.

The Annual joint meeting of WJAS with the Washington Academy of Sciences takes place on March 19. At that time, the Junior Academy will honor the Talent Search winners.

SCIENCE AND DEVELOPMENT

A new physical sciences lecture hall at the University of Maryland has been named in honor of Nathan L. Drake, former head of the Chemistry Department, who died last October after 33 years of distinguished service to the University. The building, adjacent to the chemistry building at the north end of the campus, was constructed under Dr. Drake's supervision at a cost of about $250,000. It has a large lecture hall with a capacity of 360, a smaller lecture hall, and a classroom.

Ciencia interamericana is the name of a new bimonthly periodical, of which Volume 1, Number 1 has just been issued by the Panamerican Union. This publication will carry news of scientific accomplishments in countries of the Western Hemisphere, as well as reports on activities of the Panamerican Union in various fields of science. The first issue contains a feature article by Bernardo Houssay, "Importancia del adelanto cientifico para el desarrollo y prosperidad de las Americas"; another on "El Oceano —La ultima gran frontera"; news of the Organization of American States; and sundry reports on hemispheric scientific activity.

The Smithsonian Institution has received and placed on display a carbon specimen received from French Equatorial Africa, that weighs 740.25 carats and is the largest in any U. S. museum, and possibly in the world. Carbon, sometimes called carbonado or black diamond, is an opaque, black, tough, compact variety of diamond. It is unexcelled for diamond rock drilling, but because of its scarcity is used only where ordinary industrial diamonds cannot operate. It is also useful in truing hard rubber wheels and other difficult grinding operations.